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SHORT COMMUNICATION

DISCUSSION: APPLICATION OF THE QDa–Md METHOD OF ENVIRONMENTAL DISCRIMINATION TO PARTICLE SIZE ANALYSIS OF FINE SEDIMENTS

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ABSTRACT

Duck's recent finding (R. W. Duck, *Earth Surface Processes and Landforms*, 1994, **19**, 525–529) that QDa and Md parameters derived from pipette and SediGraph analysis of sediments from Loch Tummel returned similar results can be interpreted in two ways. The observed consistency could result from (i) a general agreement between the methods (as is suggested by Duck) or (ii) from the use of inappropriate parameters (Md and QDa) to describe polymodal distributions.

KEY WORDS grain size; polymodal; statistical parameters

PIPETTE VS. SEDIGRAPH DATA

There is a wealth of published and unpublished data comparing these (and other) methods of grain-size analysis (e.g. Welch *et al.*, 1979; Stein, 1985; Lara and Matthes, 1986; Singer *et al.*, 1988; Coakley and Syvitski, 1991; McCave and Syvitski, 1991). For the most part there is little disagreement that SediGraph data closely resemble those derived from the pipette method, especially for medium- to fine-grained silt. Duck's (1994) findings agree. Like previous studies (e.g. Welch *et al.*, 1979), Duck found that the SediGraph returns finer results than pipette analysis and that the difference is significantly greater at the fine end of the grain-size distribution (Duck, 1994, Table I). The distribution is thus skewed (with respect to pipette data) by the addition of a fine-grained tail. However, the use of a statistical tool that effectively ignores changes in the margins of the distribution raises questions as to the validity of the comparison.

THE QDa–Md METHOD

The arithmetic (metric) quartile deviation (QDa) used by Duck (1994) has a long and somewhat chequered history. The parameter is based on Trask's (1930, 1932) arithmetic measure of spread. However, as Buller and McManus (1972) pointed out, the original measure (QDa $= [D_{25} - D_{75}]/2$) describes only the middle section of the grain-size distribution and they recommended that the 16th and 84th percentiles be used instead (QDa $= [D_{16} - D_{84}]/2$). Surprisingly, Duck has retained the earlier and more restrictive derivation of QDa even though it is known that the SediGraph results are less comparable at the margins of the distribution – sections of the curve largely ignored by Duck's methodology.

It is perhaps surprising that Duck should choose the QDa–Md method at all, given that both parameters have doubtful sedimentological meaning. The arithmetic quartile deviation (and indeed many similar

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measures) was derived as a method for graphically approximating standard deviation at a time when access to computing facilities was greatly limited (see Folk (1996, p. 73): 'A major controversy is whether one should use graphs and simple intercept statistics, or computing machine and moment statistics'). With electronically collected digital data it is now possible to determine standard deviations directly, if indeed standard deviation is a sedimentologically appropriate parameter (see below). The median (50th percentile) is also somewhat problematic, describing the mid-point in a distribution where, in a bi- or polymodal case there may be no grains of that size present at all (a point noted by Folk (1974, p. 41): 'it does not reflect the overall size of the distribution well. For bimodal sediments it is almost worthless').

From Duck's recent paper it is not possible to determine the character of the grain-size distributions used in his comparison. However, reference is made to an earlier paper (Duck, 1986) which sheds some (revealing) light on the nature of the sediments. At least some of the samples used in his comparison are polymodal, containing up to four identifiable modes (Duck, 1986, figures 6 and 7). It is not clear how many size classes were measured and in the absence of the original raw data it would be unwise to postulate the environmental significance of these modes. However, it is clear (as Duck (1986, p. 312) recognized) that the presence of polymodal grain-size distributions seriously compromises the usefulness of most standard statistical measures (e.g. Folk and Ward, 1957; Friedman, 1967; Koldijk, 1968; Folk, 1976; Ashley, 1978). It therefore seems unreasonable that two measures (Md and QDa) which focus on the mid-section of an imaginary normal distribution should be used to evaluate the comparability of SediGraph and pipette analysis of polymodal sediments. This type of study would have yielded a much more meaningful comparison if a multivariate analysis that considered the entire grain-size distribution were applied.

In their day, numerical parameters which were graphically derived from cumulative frequency curves provided a useful method for comparing grain-size data where the datasets were too large to permit quantitative comparison by eye. However, with the current availability of large, high quality datasets from automated devices (e.g. SediGraphs, Coulter Counters, laser particle sizers) together with computing facilities for data manipulation, the use of these simple approximations, along with the consequent obfuscation of the raw data, is no longer needed nor justified.

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